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Industrial minerals operations and opportunities in Newfoundland and Labrador & growing links with the US eastern seaboard

by

P.L. Dean, J.R. Meyer and A.F. Howse
Newfoundland Department of Mines, St. John's, Newfoundland, Canada

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Newfoundland Department of Mines, St John's, Newfoundland, Canada

Newfoundland and Labrador, the most eastern of the ten Canadian provinces, comprises a land mass almost one and a half times larger than New England. Strategically located at the entrance to the Gulf of St Lawrence the province lies along major North Atlantic shipping lanes linking the industrial hearts of North America and Europe (Figure 1). Within the province, industrial mineral deposits are widespread, and most producers are located near deep harbours along the province's 17,000 km coastline (Figure 2). Industrial mineral commodities are mined and shipped directly to local and world markets. The proximity of mineral deposits to deep sheltered harbours and the availability of large bulk carriers is causing significant expansion in the province's production and trade of industrial minerals.

The USA's eastern seaboard already constitutes an important market for industrial minerals from Newfoundland and Labrador and the potential for future development opportunities is great. The province produces a wide variety of industrial minerals including pyrophyllite, asbestos, gypsum, fluorspar, dolomite, limestone, semi-precious stones, slate, cement, aggregates, brick, and other structural materials. Large reserves of these and other industrial minerals are known and several deposits are currently in the early stages of development.

This paper describes the existing industrial mineral production in the province of Newfoundland and Labrador and outlines some of the development opportunities that are available in view of the expanding trade links with the US Eastern Seaboard.

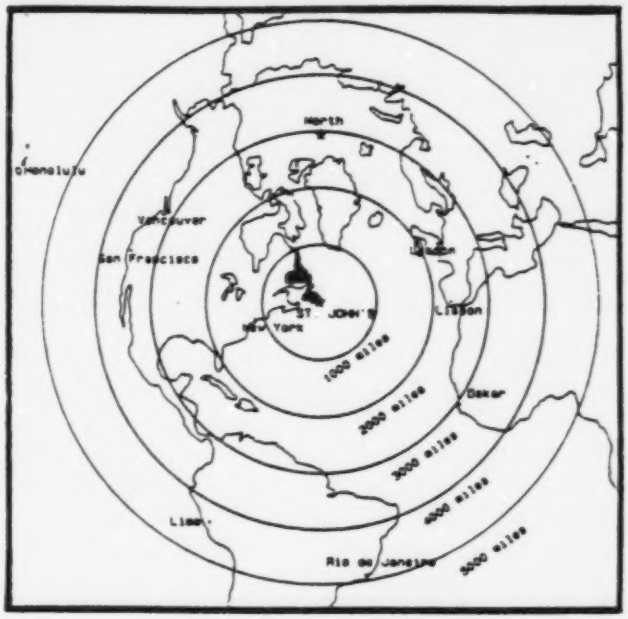

Figure 1: Location of Newfoundland and Labrador. (Modified from " The Newfoundland Centred World Map " produced by the Department of Geography, Memorial University, St John's, Newfoundland.)

CURRENT INDUSTRIAL MINERALS OPERATIONS

Pyrophyllite

Pyrophyllite is mined by Newfoundland Minerals Ltd from a deposit near Manuels, Conception Bay (Figure 3). This quarry operation is the only producer of pyrophyllite in Canada. It has been in continuous production since 1956, with Ltd production during the periods 1904-1905 and 1938-48. The pyrophyllite occurs within altered felsic volcanic rocks of Late Precambrian age where they have been intruded by the Late Precambrian Holly-

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7. Dexter Construction Materials (gypsum)
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33. Strange Lake (Zr-Y-Nb-REE)
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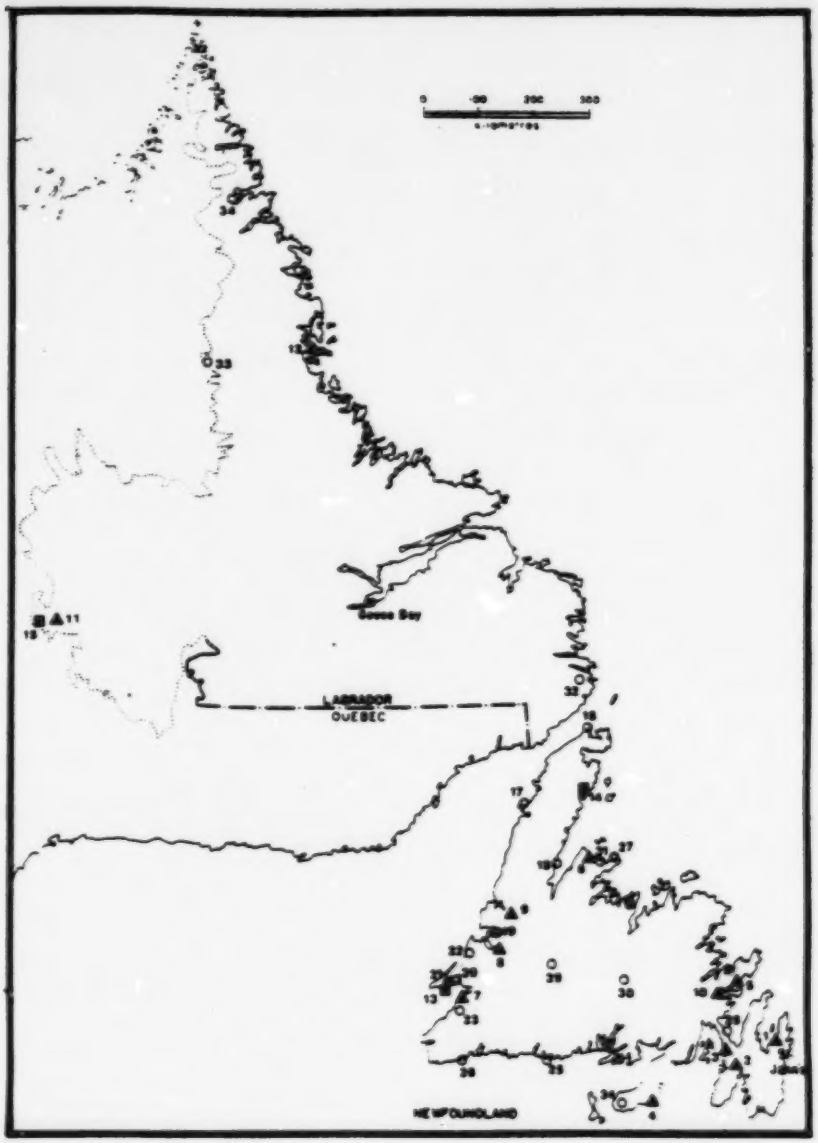

Figure 2: Location of industrial mineral deposits in Newfoundland and Labrador.

rood granite pluton. The ore consists of a fine grained assemblage of pyropyllite, sericite, quartz, and diaspore. Cut-off grade is 17% Al_2O_3.

Primary crushing is done at the quarry site and the crushed material (minus 18 cm) is trucked 5 km to a stockpile at tide water. There is no on-site upgrading. However, selective quarrying, combined with intensive sampling, enables the company to ship several grades of high quality pyropyllite. All production, which averages 40,000 tonnes annually, is shipped to plants owned by American Olean Tile Company Inc. (the parent company of Newfoundland Minerals) in Pennsylvania and Mississippi, where it is used in the manufacture of high quality ceramic tiles and electrical porcelain. Small tonnages are shipped to Germany, for refractory applications and some of the lower grade material is used locally in the manufacture of joint filler and paints. At the current rate of production (250 tonnes/day), reserves are sufficient for approximately 40 years.

Figure 3: Manuels pyrophyllite mine, Conception Bay

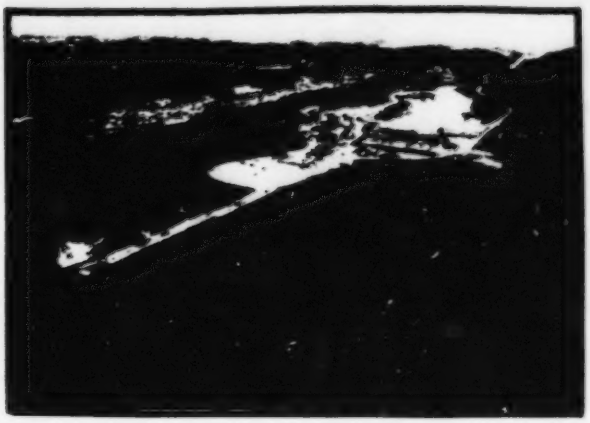

Figure 4: Phosphorus reduction plant and slag-aggregate operation at Long Harbour, Placentia Bay.

Silica

Quartzite deposits near Dunville, Placentia Bay, are quarried to provide silica flux for the phosphorus reduction plant of Albright and Wilson at Long Harbour, 15 km to the north. The quarries are operated by Dunville Mining Ltd, a subsidiary of Albright and Wilson Americas. The quartzites occur within the Random Formation, an Eocambrian clastic sedimentary unit widely distributed throughout south-eastern Newfoundland. The quartzite deposits form resistant hillocks or ridges which stand above the surrounding terrain.

The quarry operates from May to December and produces approximately 150,000 tpa. The quartzite is crushed and screened on site and trucked to the phosphorus plant at Long Harbour. Reserves are approximately 7m. tonnes with an average grade of 94.75% SiO_2, 2.35% Al_2O_3 and 1.45% Fe_2O_3. Ore to waste ratio is 9.6 to 1.

Slag aggregate

In July, 1986 Albright and Wilson Americas (then ERCO Industries) began crushing and exporting slag aggregate from its phosphorus reduction plant at Long Harbour, Placentia Bay (Figure 4). The slag is a waste product from the plant which annually imports about 500,000 tonnes of phosphate rock from Florida. The slag is generally vesicular and is considered a lightweight aggregate. Five classes of washed and screened product are shipped to Florida where it is used mainly in road construction and in drainage systems. The company expects to export about 270,000 tonnes of aggregate in 1988 from a crushing and screening plant capable of producing 320,000 tonnes annually. The project is economically feasible because of cheap back-haul shipping rates from Newfoundland to Florida and the strong demand for aggregate in cities along the US eastern seaboard. These factors are likely to cause a growth in the Newfoundland aggregate export trade.

Fluorspar

In 1987, St Lawrence Fluorspar Ltd began producing acid grade fluorspar at St Lawrence on the Burin Peninsula. The fluorspar mines, unique in Canada, had operated during a 44 year period beginning in 1933 and ending in 1977. At that time, the owner, Alcan, ceased operations at St Lawrence and purchased fluorspar on the open market. The mining properties subsequently reverted to the provincial government who then invited proposals for their development. This led to an agreement with Minworth Ltd, the parent company of St Lawrence Fluorspar, to reactivate fluorspar production at St Lawrence.

About 40 distinct fluorite veins are known in the St Lawrence area but not all of these are commercial deposits. Current production is from the Blue Beach and Tarefare veins, two major vein systems

with proved, probable, and possible reserves in excess of 5m. tonnes at a grade of 35% CaF_2.

Almost all of the veins lie within the St Lawrence Granite, a high level peralkaline Carboniferous pluton which intrudes volcanic and sedimentary rocks of Cambrian and Late Precambrian age. All are fissure fillings located in tensional cracks that developed as a result of regional stress and contraction during cooling of the granite. The veins vary in length from a few hundred metres to over two kilometres, and show a strong tendency to pinch and swell in both horizontal and vertical directions producing a series of lenticular orebodies within each vein system.

Fluorspar is mined from underground operations and from shallow open pits. Run of mine ore is subjected to primary and secondary crushing, then treatment by flotation. The current annual capacity of the plant is 75,000 tonnes of acid grade spar a year. The product is shipped from nearby St Lawrence Harbour to markets in the US, with occasional shipments to Europe. The fluorspar, a high quality product containing low arsenic and phosphorus, is well received in the market place.

Slate

Insular Newfoundland is endowed with several areas of good quality slate located at tide water. The most commercially attractive deposits are found on the north side of Smith Sound in Trinity Bay, where folded Cambrian strata host attractive green and purple varieties of the stone. Between 1853 and 1909 quarries in this region produced roofing slates for English markets, notably London and Newcastle. In 1986 one of these long dormant quarries, located at Nut Cove, was reactivated by a local company, Island Tile and Slate Ltd. An experienced American quarryman was hired to train a local work force and the company started producing roofing and flooring slate for markets in Montreal and New York, as well as for the local market.

The resurgence in the use of slate as a construction material, particularly for roofing, has created a strong demand for this commodity in Canada and the USA. Since Newfoundland's slate deposits are of a high quality and located at tide water, this province is uniquely situated to help meet the demand.

Asbestos

Baie Verte Mines Inc. produces asbestos from a large deposit just north of the town of Baie Verte in north-central Newfoundland. The deposit was discovered in 1955 by the M. J. Boylen organisation and acquired in the same year by Advocate Mines Ltd. The property was brought into full production in 1963. The operation was managed by Canadian Johns Manville until 1981 when Advocate Mines announced that the operation was closing due to marketing problems and economic conditions.

In early 1982, Transpacific Resources submitted a takeover proposal to government and the owners. A subsidiary, Baie Verte Mines, was formed and began production in September, 1982. In August, 1987, Transpacific Resources sold its interest in Baie Verte Mines Ltd to a company controlled by Mineral Commodities Inc. of Australia. It is believed that the new corporate structure will strengthen the marketing capabilities of Baie Verte Mines and will also lead to the installation of a wet milling process to recover asbestos fibre from the large stockpile of tailings.

The asbestos deposit occurs within serpentinised ultramafic rocks which form part of a discontinuous linear belt of such rocks extending some 80 km to the south-west. These ultramafics are part of a disrupted and metamorphosed lower Palaeozoic ophiolite sequence. The orebody is a basin-like zone of fibre development within the ultramafic body with the fibre best developed at the margins of the basin. The fibre-bearing mass is approximately 1,600 metres long, 800 metres wide and extends to a depth of 300 metres. The chrysotile fibre occurs as a vein stockwork with fibre averaging 5 to 8 mm in length, but with lengths up to 5 cm in some areas of the deposit. Standard open pit methods are used in mining the deposit, with benches approximately 15 metres high. The resulting asbestos product is mainly a high grade Group 5 fibre with lesser amounts of Group 4 and Group 6. The fibre is bagged in 45 kg blocks and shipped from the mine site to

markets in Asia and Europe. Current annual production is approximately 60,000 tonnes of asbestos fibre.

Gypsum

The gypsum deposits in the sea cliffs of Bay St George in south-western Newfoundland were noted by the earliest geologists in the area, but commercial production was not achieved until 1952. At that time, Atlantic Gypsum, a provincial crown corporation, began manufacturing of gypsum wallboard at Humbermouth near Corner Brook using gypsum quarried at Flat Bay, Bay St George (Figure 5). In

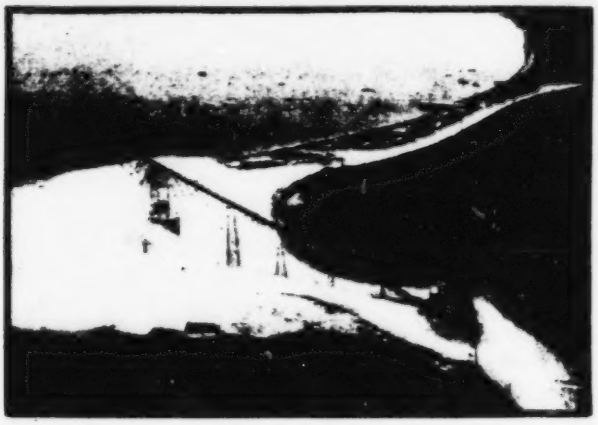

Figure 5: Gypsum stockpile at Flat Bay, Western Newfoundland.

1960, the Flintkote Company took over the quarry operation under an agreement with Atlantic Gypsum and the provincial government which gave Flintkote exclusive rights at Flat Bay. Quarry operations at Flat Bay were conducted by the Flintkote Company of Canada Ltd on behalf of the parent US company. In October 1986 Flintkote's gypsum operations were purchased by Domtar,and production continued until December 1987.

The gypsum is part of an evaporite sequence that attains a thickness of 300 metres within the Codroy Group of Mississippian age. The Flat Bay deposits flank both sides of a gently plunging northeast trending anticline. The quarries are located in the north-eastern nose of this structure. Reserves in the area are estimated to be sufficient for 70 years at annual production rates of 600,000 tonnes. The gypsum rock is conveyed from the quarry site by aerial bucket-way and trucks to a stockpile at tide water for subsequent shipment to plants in the eastern US and Canada. A smaller portion of production is transported to the Atlantic Gypsum wallboard plant and the North Star cement plant at Corner Brook. Domtar is presently seeking a buyer for the Flat Bay gypsum properties because of its decision to use other sources of gypsum to supply its wallboard plants. Gypsum production is likely to continue in the Bay St George area because of the large reserves of high quality gypsum and their favourable location near the coast, with easy access to shipping.

Limestone-cement

North Star Cement Ltd operates two limestone quarries and a shale quarry to supply its cement plant at Corner Brook in western Newfoundland. The plant and quarries are located on the eastern outskirts of the city less than one kilometre from the shipping pier and railway station at Humbermouth. The calcitic "limestone" is quarried from marble deposits of the Corner Brook Formation, part of the widespread thick Lower Palaeozoic carbonates of western Newfoundland. The limestones grade from 53 to 55% CaO and 1 to 2% MgO. Close quarrying control is necessary to avoid high magnesium sections. The shale is obtained from nearby strata which overlie the carbonates, and gypsum is obtained from the St George's gypsum mine at Flat Bay, 80 km to the south.

Originally a wet process operation, the cement plant has converted to a dry process and increased annual capacity by 30% to 100,000 tonnes. The cement is marketed under the trade name, "North Star" and supplies most in-province markets as well as a portion of the Atlantic Canada market. The plant has recently undergone a modernisation programme.

Brick Shale

Newfoundland's only brick plant is operated by Trinity Brick Products Ltd at Milton, 9.6 km north of Clarenville, Trinity Bay, in south-eastern Newfoundland. The operations began in 1886 using

the "soft mud process" with clay obtained from an adjacent pit. In 1954 the plant was converted to the "dry-press process" using shale from the relatively soft and workable shale beds of the Ordovician Clarenville Formation on nearby Random Island. Shale reserves are sufficient for many years at the present rate of 4m. bricks annually. A major expansion, including modifying the kiln and dryer, was completed in 1985. This increased plant capacity to 5m. bricks annually. All production is currently marketed in Newfoundland.

Agricultural limestone

Newfoundland began producing agricultural limestone in 1986 from a large, high-magnesium deposit at Cormack in western Newfoundland. Havelock Lime Works, the operators of the quarry supply the local market for ag-lime.

Dolomitic marble

A new industrial mineral deposit was brought into production in 1986 by the Iron Ore Company of Canada (IOCC) in western Labrador . Dolomitic marble is being mined by IOCC for use in the production of self-fluxing "dolomitic-type" iron ore pellets.

The same sedimentary sequence which hosts the large iron ore deposits in western Labrador also contains a dolomitic marble unit, the Denault Formation. In 1984, the Newfoundland Department of Mines carried out geological surveys which resulted in the discovery of two high quality dolomitic marble deposits which could meet the chemical specifications for self-fluxing pellets, ie. high MgO, less then 4% SiO_2, and low alkali content. IOCC subsequently established sufficient reserves to begin a quarry operation by early June 1986, and by the end of July more than 100,000 tonnes had been removed. In that year IOCC produced and shipped approximately 1.2m. tonnes of fluxed pellets to Dofasco and Bethlehem Steel. In 1987 IOCC quarried approximately 140,000 tonnes and defined reserves for another 2 years in the immediate area. Production is also planned from a larger deposit to the north of the existing quarry.

Labradorite

Since its discovery in 1770, labradorite has been quarried intermittently from Tabor Island near Nain, on the north coast of Labrador. At the present time, the quarry is being worked by a local native organisation, the Labrador Inuit Development Corporation (LIDC), to provide select high quality gemstone material for local craftsmen and for sale. The group is reorganising and expanding the further development and sale of labradorite and labradorite products from the Tabor Island Quarry. Reserves at this quarry and in the surrounding area are sufficient to supply the local needs and to support an international export trade for the foreseeable future.

NEW DEVELOPING PROJECTS

Limestone aggregates

Newfoundland Resources and Mining Ltd (owned by Explaura Holdings plc) announced plans in mid-1987 to proceed with the development of a large limestone aggregate operation at Lower Cove on the Port Au Port Peninsula in western Newfoundland (Figure 6). The operation will eventually export 4m. tonnes of crushed stone annually to US Eastern seaboard markets.

The Port Au Port Peninsula is underlain by limestone and dolomite representing the southern part of an extensive

Figure 6: Site of planned limestone aggregate operation at Lower Cove, on the south side of the Port Au Port Peninsula.

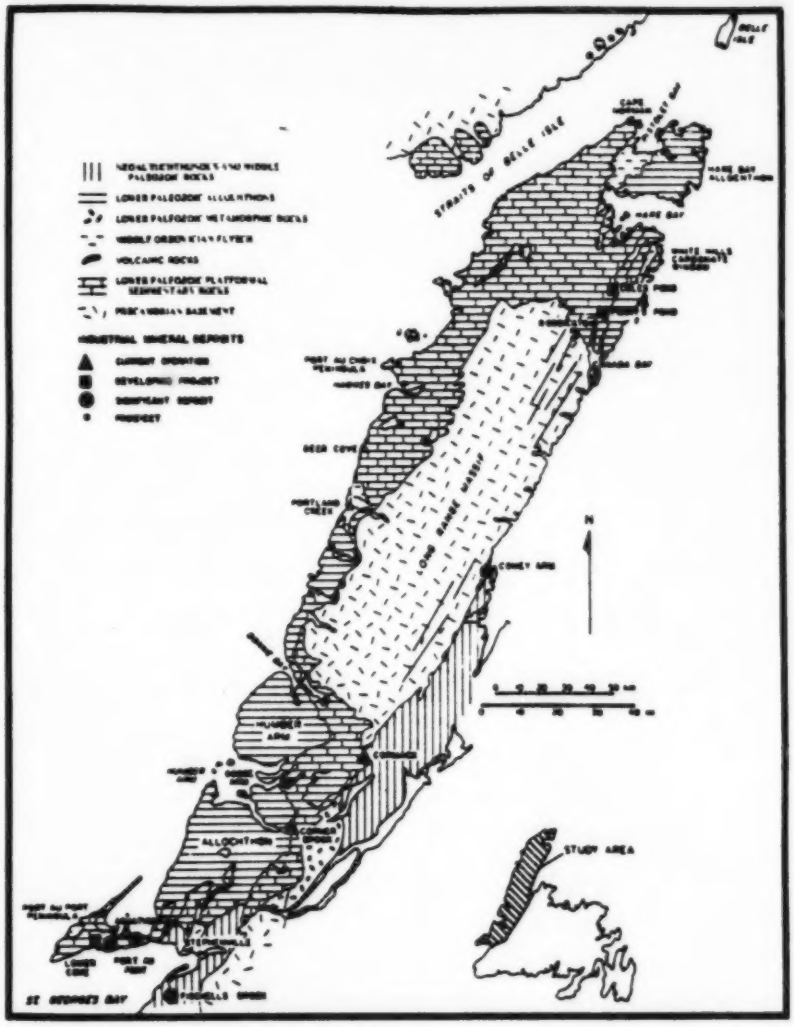

Figure 7: Geology of the carbonate belt and location of industrial mineral deposits in Western Newfoundland. (Modified from Knight and James, 1987)

north-south trending belt of Palaeozoic carbonates in western Newfoundland (Figure 7). Large reserves of limestone on tide water near Lower Cove are capable of supporting a long term quarry operation. The concept of exporting aggregate from Newfoundland to US markets is relatively new but given the province's abundant and varied sources of stone located adjacent to deep harbours, it is a trade that is likely to expand considerably in the future.

Marble

Late in 1987 the Government of Newfoundland and Labrador invited proposals for the development of two deposits of high purity white marble located near Roddickton on the Great Northern Peninsula. The deposits were identified during the course of a three year assessment of Newfoundland's marble resources by the province's Department of Mines. The Roddickton marble deposits, located near Penny's Pond and Coles Pond occur along a deformed zone of Lower Ordovician carbonate rocks which underlie the Hare Bay Allochthon. Diamond drilling of the deposits delineated a minimum total of 3m. tonnes grading 96.6% $CaCO_3$, 1.55% SiO_2. 0.73% $MgCO_3$, 0.37% Al_2O_3 and 0.13% FeO. Dry brightness is in the order of 96%. The Roddickton marble is economically attractive because of its high degree of purity, brightness and proximity to deep harbours. It may be used in a number of industrial applications including uses as a filler in paint, plastics and white pigments for paper. The potential for additional reserves is excellent.

Silica

In 1984, a surface sampling programme by the Department of Mines confirmed that

large quartzite ridges near Labrador City in western Labrador are extremely pure and represent immense reserves of high quality silica. A drilling programme in 1986 in one of these ridges delineated of 20m. tonnes of quartzite with an average content of 99.3% SiO_2, less than 0.20% Al_2O_3, and 0.24% Fe_2O_3. Higher grades were encountered in some of the drilling and beneficiation studies have indicated that the total level of impurities can be reduced to less than 50 ppm.

A unique deposit of friable quartzite adjacent to a highway three kilometres east of Labrador City was also drilled in 1986, and a minimum of 4m. tonnes were delineated. The best drillhole averaged 99.23% SiO_2, 0.55% Al_2O_3, and 0.09% Fe_2O_3 over 21 metres. The friable nature of this deposit, thought to be a result of Cretaceous weathering, would allow this deposit to be hydraulically mined. Attrition scrubbing and magnetic separation work carried out by CANMET reduced impurity levels to 0.01% Al_2O_3 and 0.01% Fe_2O_3. This deposit has recently been acquired by Blue River Mines, who have been joined by Ekaton Industries in planning a programme to evaluate the possibilities for development.

The Labrador City quartzite deposits are considered to have excellent potential for development and local processing. The reserves are large, the quality is excellent, and infrastructure, transportation, and energy systems are already in place, servicing the large iron ore operations of the Iron Ore Company of Canada and Wabush Mines.

OPPORTUNITIES FOR FURTHER DEVELOPMENT

The province of Newfoundland and Labrador contains a wide variety of geological environments representing geological time from the earliest Precambrian to the Mesozoic (Figure 8). There are more than

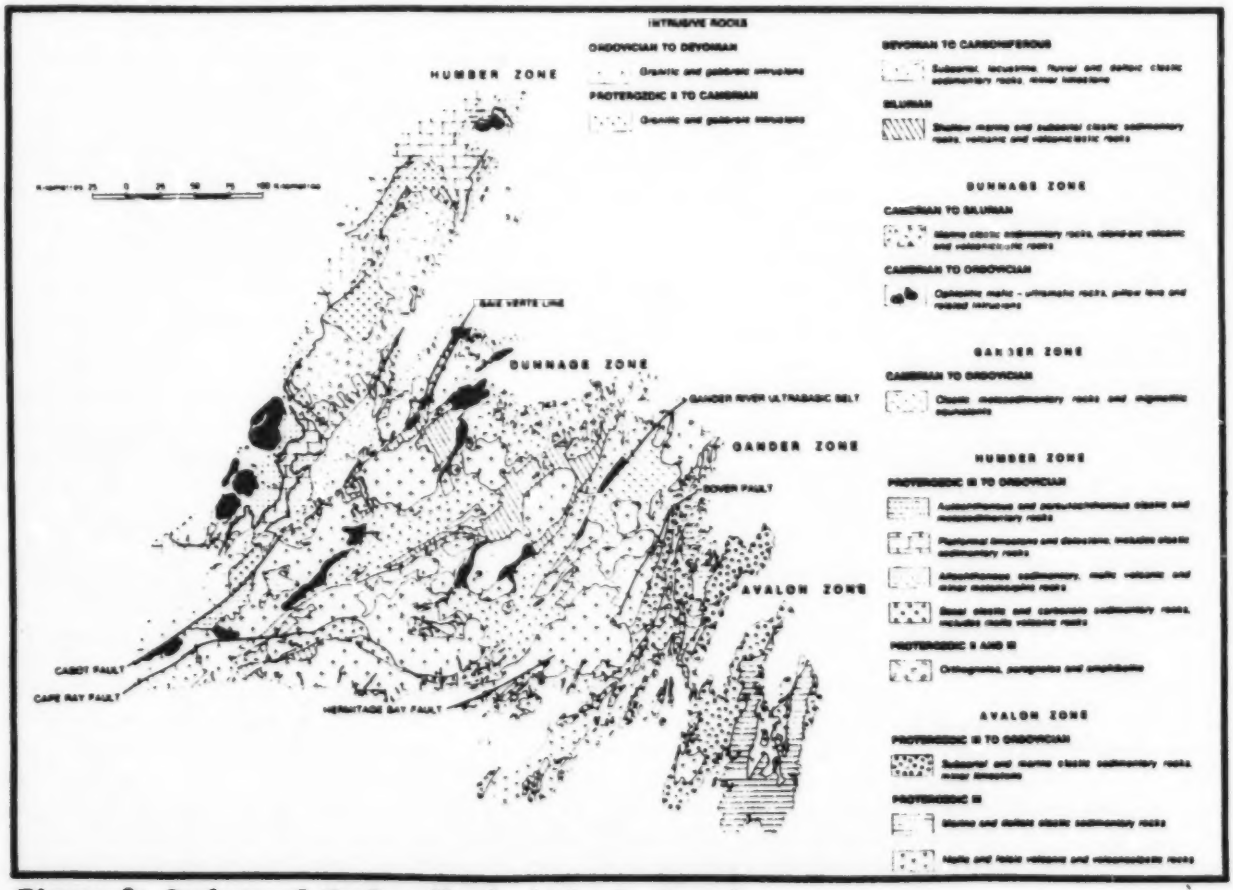

Figure 8: Geology of Newfoundland (John P. Hayes)
Simplified from Colman-Sadd and Hayes (in prep.)

4,000 documented mineral deposits and occurrences in the Province covering a wide range of commodities including most of the commercially valuable metals and industrial minerals. In addition to known occurrences and areas with high potential for further discoveries, there are a significant number of industrial mineral deposits with known geological reserves which are likely future producers given the appropriate marketing, technological, and economic factors.

The geology of western of Newfoundland is dominated by Lower Palaeozoic carbonate rocks containing numerous deposits of high quality limestone, dolomite and marble. The Port Au Port Peninsula, at the southern end of this carbonate belt, is particularly well endowed with large reserves of limestone and dolomite and thus is currently the focus of attention as a potential site for new developments. The Aguathuna Limestone Quarry (Figure 9), on the north-east shore of the peninsula, was a source of flux for the Dominion Steel and Coal Corporation for nearly 50 years with over 10m. tonnes shipped. The quarry may be reactivated as a source of limestone which may be used in the making of fluxed pellets for Labrador iron ore, and as aggregate for export to the eastern USA. Also in western Newfoundland, the Bay of Islands Igneous Complex south-west of Corner Brook hosts deposits of asbestos and chromite, and the Bay St George Carboniferous Basin contains deposits of barytes, celestite, and gypsum as well as sodium and potassium salts.

Figure 9: Aguathuna limestone quarry, on the north side of the Port Au Port Peninsula.

On the east coast of Newfoundland there are several known deposits of Eocambrian quartzite similar to that being mined at Dunville. The largest deposit assessed by diamond drilling is at Fortune where a reserve of 8.8m. tonnes grading 96.4% SiO_2, 1.5% Al_2O_3 and 0.5% Fe_2O_3 has been outlined.

At Grey River on the south-west coast, a large quartz deposit contains approximately 12m. tonnes of material grading 95.5% SiO_2 and beneficiation tests have shown the grade can be improved significantly. Smaller high purity quartz vein deposits with tonnages in excess of 1m. tonnes are located near tide water in several areas of Newfoundland.

Barytes deposits of varying degrees of significance are found throughout Newfoundland. The greatest number of occurrences are located on the Avalon Platform where numerous small high purity vein deposits exist along the western Avalon Peninsula with particular concentrations in Avalon Isthmus and St Bride's -Cape St Mary's regions. These veins typically consist of narrow (up to one metre wide) bladed or tabular crystal aggregates occupying faults and commonly associated with quartz and/or calcite. They generally grade more than 90% $BaSO_4$. One such vein, the Colliers Point deposit in south-eastern Trinity Bay has intermittently produced barytes for use in drilling for oil and gas in the Newfoundland offshore areas.

The province's largest reserve of barytes is contained in the mill tailings from the exhausted Buchans Mine in Central Newfoundland. The barytes tailings accumulated during the mining of barytes polymetallic sulphide bodies hosted by Ordovician volcanic rocks. Approximately 1.2m. tonnes of recoverable tailings averaging 35% $BaSO_4$ are contained in two tailings ponds. A plant capable of recovering the barytes is located near the deposit. The plant can produce a barytes concentrate suitable for use as a weighting agent in drilling fluids.

In Labrador, the Department of Mines is currently evaluating three dimension stone prospects south of Nain. Unlike the gemstone quarry at Tabor Island where

extremely coarse crystalline pegmatite deposits are being worked, these dimension stone prospects consist of medium to coarse crystalline anorthosite with 0.5 to 5.0 cm chatoyant blue labradorite crystals. Second quality material from the gemstone quarry on Tabor Island is being evaluated as a source of labradorite aggregate. The aggregate is being tested for use in making of terrazzo tiles, pre-cast concrete panels and lightweight, epoxy-backed panels.

In northern Labrador a unique deposit of zirconium-niobium-yttrium-beryllium-rare earths occurs near Strange Lake on the Quebec-Labrador border. This world class deposit was discovered by the Iron Ore Company of Canada in 1979. Indicated reserves exceed 30m. tonnes, grading 3.25% ZrO_2, 0.66% Y_2O_3, 0.12% BeO, 0.56% Nb_2O_5 and 1.3% rare earth oxides. Metallurgical studies show that the ore minerals are leachable and a concentrate of oxides can be achieved.

SUMMARY

The eastern USA is the traditional market area for minerals produced in Newfoundland and Labrador. For more than thirty years, commodities such as iron ore, pyrophyllite, gypsum, and fluorspar have been shipped in bulk carriers to eastern US ports. In recent years this trade has increased to include the import of phosphate rock from Florida and the export of slag aggregate to US markets. The reactivated slate industry in Newfoundland is also serving the markets of eastern seaboard cities of the USA.

Because of the attractive economics of marine transportation afforded by large bulk carriers, Newfoundland will soon begin to exporting limestone aggregate directly from quarries at tide water to cities on the US eastern seaboard.

Marine transportation of minerals from Newfoundland producers to US markets is a key factor in the success of many mining operations in Newfoundland and Labrador. It has been the basis for sustained growth in the production and trade of industrial minerals and is vitally important to the development of new producers.

The traditional trade in industrial minerals with the eastern US is likely to continue and expand into the next century as developers realise the potential of the mineral wealth in the coastal regions of Newfoundland and Labrador within easy access of marine transportation.

Additional information on the industrial minerals of Newfoundland and Labrador is available from the authors and the Department of Mines, Government of Newfoundland and Labrador.